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Shawkat Hammoudeh
Duc Khuong Nguyen
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IPAG Business School
184, Boulevard Saint-Germain
75006 Paris
France

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China's Monetary Policy and Commodity Prices

Shawkat Hammoudeh[a], Duc Khuong Nguyen[b,*], Ricardo M. Sousa[c,d]

[a] *LeBow College of Business, Drexel University, 3200 Market Street, Philadelphia, PA 19104, USA*
[b] *IPAG Business School, 184, Boulevard Saint-Germain, 75006 Paris, France*
[c] *University of Minho, Department of Economics and Economic Policies Research Unit (NIPE), Campus of Gualtar, 4710-057 - Braga, Portugal*
[d] *London School of Economics and Political Science, LSE Alumni Association, Houghton Street, London WC2 2AE, United Kingdom*

Abstract

This paper examines the effects of the monetary policy of China on commodity prices. Using a Bayesian Structural VAR, we identify shocks to the interest rate as a price rule and to the monetary aggregate (M2) as a quantity rule, and then evaluate their impacts on commodity prices. Those prices include the aggregate commodity price index and all its major constituents. Our results suggest that a positive interest rate (contractionary) shock has a negative and persistent effect on commodity prices. Additionally, the beverages and metals are the commodities whose prices fall by most in response to changes in the Chinese monetary policy. In what concerns the positive shock to the growth rate of the monetary aggregate, we find that although it does not have a significant impact on the commodity price aggregate, such result "hides" important heterogeneity across different types of commodity prices. Finally, we show that while adjusting the growth rate of the monetary aggregate and changing the interest rates appear to be macroeconomic stabilizing tools of similar power, the price instrument seems more effective in explaining the dynamics of commodity prices than the quantity one.

Keywords: monetary policy, commodity prices, Bayesian Structural VAR, China.
JEL classification: E37, E52.

* Corresponding author: 184, Boulevard Saint-Germain, 75006 Paris, France. Phone: +33 (0)1 53 63 36 00 - Fax: +33 (0)1 45 44 40 46
Email addresses: hammousm@drexel.edu (Shawkat Hammoudeh), duc.nguyen@ipag.fr (Duc Khuong Nguyen), and rjsousa@alumni.lse.ac.uk (Ricardo M. Sousa).

1. Introduction

China's institutional, economic and financial reforms towards a market-oriented economy over the last three decades have led to a number of significant transformations in the Chinese society and resulted in unprecedented economic success. The major policies of the reform process include, for example, the adoption of the household responsibility system in the agricultural sector, the market openings to foreign investment, the privatization program of state-owned companies, and the gradual removal of price controls and protectionist regulations. Not surprisingly, China had registered double-digit economic growth until the onset of the 2007/2008 global financial crisis (GFC). This high economic growth has fuelled the international demand for commodities and led to a global boom in their prices. China currently consumes 10% of the world's total oil demand and 40% of the growth in this global demand. It also consumes 40% of the world's copper demand, making it the highest world consumer of copper. Moreover, it has become the world's largest gold-consuming nation, overtaking India in 2013. This country has also become the second largest global economy behind the United States, which is also described as the world's factory.

Another important fact of China's influence on commodity prices is that few countries have integrated into the world economy as fast as China has since 1978, particularly since its accession to the World Trade Organisation in 2001. The world's most populous country is emerging as a world workshop and export machine. While the magnitude of its international trade is almost close to that of the United States in 2012, China has confirmed its trade leadership by capturing a 10% share of the global trade in 2013. Interestingly, its per capita consumption of most commodities is immature and posed to grow rapidly in the future. For example, China's per capita consumption is one-fifth of that of Korea for copper, aluminium, steel and oil. There is therefore con-

siderable scope for China's commodity demand to grow as its per capita income rises. Most of the growth in the marginal global demand for commodities has been generated by its high economic growth and this growth has been export-led. Recently, China has started to rebalance its export-based growth strategy by giving more leverage to its domestic demand.

Given the important role of commodities in the Chinese economy and the potential impact of its monetary policy stance on commodity prices as stated by the recent literature (e.g., Mallick and Sousa, 2012; Ratti and Vespignani, 2013; Belke et al., 2014), this paper examines the effects of China's monetary policy on commodity prices. We first use a Bayesian Structural VAR to identify the stance of this monetary policy with shocks affecting the Chinese interest rate and monetary aggregate (M2), and then evaluate their impacts on the aggregate commodity prices and various sector commodity prices. Such as study is motivated by the fact that unlike Western central banks which typically employ one policy instrument (i.e. the short-term interest rate), China's monetary authority normally applies both price (interest rates) and quantity (the money supply) instruments. Moreover, the scope of the intervention of the People's Bank of China is also broader, as it is expected to (i) ensure price stability and promote economic growth, (ii) maximize employment, (iii) achieve the equilibrium of the balance of payments, and (iv) promote financial liberalization and reforms. Thus, the central bank targets both short- and long-term interest rates, often uses the reserve requirement, and employs forcefully target loans to direct the Chinese banking system which is dominated by state-owned and policy banks and generates a somewhat imperfect transmission channel of the monetary policy.

It will thus be important to see if these different policy tools (interest rate vs. money supply) of the Chinese monetary policy have varying impacts on the prices of

different groups of commodities. The more money from expansionary monetary policy is created, the more violent swings are likely to appear in speculation and in the fundamentals. This may prop up commodity prices that would have long ago collapsed and misallocated.

Frankel (2008) advances a theory which posits that low real interest rates have contributed to the continued rise in prices of agricultural and mineral commodities, including oil. Some economists question whether changes in the news related to supply and demand are sufficient to justify the recent rises in commodity prices. Combining the importance of China's high economic growth, strong fundamentals, different practices of monetary policy, and controlled exchange rate with the theory linking interest rates and commodity prices, our study thus contributes to the literature by discerning if China's domestic monetary policy, with its two strategy prongs that target exports and domestic demand, affects global commodity prices.

Additionally, we consider not only a global broad commodity price index but also its sectoral commodity constituents. Sector commodities differ in terms of their uses (e.g., construction, infrastructure, manufacturing and consumption), contracts and the responsiveness of businesses and households that use them to prices. There are food and energy commodities which are highly volatile due to their susceptibility to nonmonetary factors including weather and/or geopolitics. Precious metals have monetary values which relate them to the dollar exchange rate with which China has a soft peg. On other hand, industrial commodities such as raw materials are highly cyclical and sensitive to the global business cycle. Commodities such as corn, ethanol and gasoline prices are interconnected and may have spillover and feedback effects on each other.

The last few decades show that commodity prices do not move in sync as they respond to different shocks and stimuli due to those characteristics explained above.

Therefore, an examination of the impact of China's monetary policy on commodity prices is expected to produce different results which can be useful to businesses, investors and policymakers. Policy makers should be interested in considering the results within the context of China's central bank's refusal to act as the lender of last resort to help banks to get out from their financial troubles and trace this refusal on future commodity prices. They should be cognizant of the results as China is considering freeing the deposit rate and reducing financial repression if interest rates overpower monetary aggregates. The assertion that financialization of commodities and China's fast economic growth are responsible for disrupting economic development in developing countries should be also of interest to investors (Farooqi, 2012; Farooqi and Kaplinsky, 2012).

As stated earlier, a Bayesian Structural VAR (BSVAR) model is implemented to identify shocks to China's central bank's interest rates and evaluate their impacts on the aggregate commodity price index and the commodity prices of six sectors (the non-fuel commodity prices, the food prices, the beverage prices, the agricultural raw materials prices, the metals prices, and the fuel or energy commodity prices). The BSVAR model allows one to quantify the responses of a set of multiple commodity prices to shocks to the interest rate and monetary aggregate as representatives or proxies of the stance of monetary policy. Moreover, this model provides better performance over the standard VAR by accounting for the uncertainty about the probability distribution of the impulse-response functions. From a statistical point of view, this empirical specification helps to reduce estimation biases related to over-fitting problems which can come from a short data set, weak sample information or a large number of parameters to be estimated. It also allows for a better identification of the monetary policy shock, as the analysis is not conditional on a set of "true" parameters that can be sensitive to the strength of the iden-

tification and the sampling distribution of estimators and test statistics as in the case of the frequentist analysis.

Our main results suggest that a positive (contractionary) shock in policy interest rate has a negative and persistent dogging effect on the aggregate commodity price index. Additionally, the volatile and seasonal beverages and the cyclical metals are the commodities whose prices fall the most in response to the positive shock to the Chinese interest rate. Concerning the expansionary shock to the growth rate of M2 (expansionary monetary policy), we find that although it is not found to have a significant impact on the aggregate commodity price index, this finding masks important heterogeneity across different types of commodities. This makes it necessary to study the responsiveness of different commodity groups to the shocks. In particular, the non-fuel commodity prices and the metals prices are highly responsive to changes in the growth rate of M2, while food prices and fuel (energy) commodity prices are not significantly affected by the monetary shock. The non-fuel commodities are mostly cyclical in nature and thus are responsive to aggregate demand shocks, while food commodities with low demand elasticities are responsive to supply shocks such as weather conditions which are not under consideration.

Finally, we show that unexpected variations in monetary policy have a persistent effect on both the economic activity and the inflation rate and a remarkable impact on the stock price and the exchange rate. Moreover, the fraction of the variation in GDP and inflation that is due to an interest rate shock is broadly the same as that associated with the shock to the growth rate of M2, but the latter explains a smaller share of the dynamics of the various commodity prices considered. Thus, while adjusting the growth rate of the monetary aggregate and changing the interest rates appear to be macroeco-

nomic stabilizing tools of similar power, the price instrument seems to be more effective in explaining the dynamics of commodity prices.

The remainder of this article is organized as follows. Section 2 reviews the related literature. Section 3 describes the empirical methods used to assess the effects of the monetary policy on the commodity prices. Section 4 presents the data and discusses the empirical findings. In Section 5, we conclude the article.

2. A brief review of the literature

There is now a large literature focusing on the relationship between commodity prices and monetary policy management (e.g., Frankel, 1984; Pindyck and Rotemberg, 1990; Lastrapes and Selgin, 1995; Leeper and Zha, 2003; Christiano et al., 2005; Mallick and Sousa, 2012). In a pioneering work, Frankel (1984) finds evidence to suggest that the rise in money supply increases the real price(s) of commodities because the prices of many other goods are somewhat rigid, and thus relatively inflexible in the short-term. The results of Pindyck and Rotemberg (1990) also confirm the fact that the impact of monetary policy actions on commodity prices is not neutral. Leeper and Zha (2003) use a Bayesian framework to assess the effects of macroeconomic monetary policy shocks in the United States and find a large and negative effect of monetary contractions on the aggregate commodity price.

The recent study by Frankel (2008) has renewed the interest in the debate on the impact of monetary policy on commodity prices as its findings underscore the importance of the implications of monetary policy for commodity prices. Indeed, this study examines the connections between the monetary policy, and agricultural and mineral commodities for a large country such as the United States and for smaller countries. The author provides empirical support for the relationship between real interest rates

and real commodity prices, explaining this relationship by the inventory channel which states that low interest rates increase the desire to carry commodity inventories. Browne and Cronin (2010) use a cointegrating VAR framework and U.S. data and demonstrate the presence of equilibrium relationships between money, commodity prices and consumer prices, with both commodity and consumer prices being proportional to the money supply in the long run. They highlight the persistence profiles for the commodity prices since they initially overshoot their new equilibrium values in reaction to a money supply shock. In a related work, Thomson and Summers (2012) question Frankel's results based on a methodological ground that includes a lack of assessing for possible unit roots, cointegration and presence of structural breaks in the data. They do not find a significant relationship between the monetary policy and commodity prices.

Following the massive rise in the global liquidity spurred by the rapid credit growth, quantitative easing and structural shifts in the global economy such as increased demand for commodities from emerging economies and reduced manufacturing costs (Humphreys, 2010), recent works have looked at the impact of global liquidity on general inflation as well as on commodity and goods prices (e.g., Hammoudeh and Yuan, 2008, Batten et al., 2010; Brana et al., 2012; Ratti and Vespignani, 2013; Belke et al., 2014). For example, Batten et al. (2010) find that the gold volatility is explained by monetary variables, while the same analogy does not apply to other precious metal prices. Belke et al. (2014) use the cointegrated VAR model to analyze the long-run impact of the official liquidity which is created by the monetary authority on commodity and goods price inflation. Their results indicate that the global liquidity aggregate is a key driver of the long-run homogeneity of commodity and goods prices movements.

The above research strand has been extended to China as the largest producer and importer of commodities, owing to the relevance of its large economy, high economic growth, and controlled exchange rate. For instance, Farooqi (2012) examines the role played by China's demand in the rise of commodity prices and its impact on the future behavior of hard-commodity prices. The author concludes that the 2001/2012 boom was the start of an expansionary phase of a commodity super cycle. China's increase in base metals consumption has directly led to demand disruptions in the global commodity markets and offers a chance of 'commodity optimism' for resource-exporting developing countries. Roache (2012) distinguishes between shocks in aggregate activity and commodity-specific consumption in China and finds that the former shocks have significant and persistent short-run impact on oil prices but the latter have no effect on commodity prices. Some research concentrates more specifically on the impact of China's macroeconomic policies or its effect on certain commodity sectors. Using a dynamic general equilibrium model, Zhang (2009) compares the effectiveness of the price rule and the quantity rule in China. The author finds support for a higher effectiveness of the interest rate as a policy instrument for stabilizing the macroeconomy. Mallick and Sousa (2012) examine the real effects of monetary policy in the BRICS emerging economies (Brazil, Russia, India, China and South Africa) and show that a contractionary monetary policy produces an immediate reduction of the aggregate commodity price index. Jawadi et al. (2014) evaluate the macroeconomic effects of fiscal policy shocks in the same set of emerging market economies and show that an unexpected increase in the Chinese government consumption leads to a fall in the commodity price index. The authors also show that considerations about the economic growth are crucial in the case of China.

Using the VAR model and the impulse response function methodology, Sun et al. (2013) investigates empirically the long-run relationship and short-term dynamics

between China's money liquidity and Chinese aluminium price following the 2008 financial crisis. Their results show the presence of long run relationship between liquidity and aluminium prices and that the Chinese monetary authority positively significantly influences the price over long periods. The authors find varied market expectations on aluminium prices within and outside China. Ratti and Vespignani (2013) rely on a structural factor-augmented error correction (SFAVEC) model and show that a positive liquidity shock in the BRIC countries leads to a significant and persistent rise in commodity prices that is substantially larger than the effect of an unanticipated increase in liquidity in the G3 countries.

3. Empirical methodology

We estimate the following Bayesian Structural VAR (SVAR)

$$\underbrace{\Gamma(\boldsymbol{L})}_{\boldsymbol{n}\times\boldsymbol{n}}\underbrace{\boldsymbol{X}_{\boldsymbol{t}}}_{\boldsymbol{n}\times 1} = \Gamma_0 \boldsymbol{X}_{\boldsymbol{t}} + \Gamma_1 \boldsymbol{X}_{\boldsymbol{t}-1} + ... = \boldsymbol{c} + \varepsilon_{\boldsymbol{t}} \quad (1)$$

$$v_t = \Gamma_0^{-1}\varepsilon_t \ , \quad (2)$$

where $\varepsilon_t \mid X_s, s < t \sim \mathrm{N}(\underline{0}, \Lambda)$, *Γ(L)* is a matrix valued polynomial in positive powers of the lag operator *L*, Γ_0 is the matrix of coefficients characterizing the contemporaneous relationships among the variables in the system, *n* is the number of variables in the system, ε_t are the fundamental economic shocks that span the space of innovations to X_t, and v_t is the VAR innovation.

Monetary policy can be characterized as

$$\boldsymbol{i}_{\boldsymbol{t}} = \boldsymbol{f}(\Omega_{\boldsymbol{t}}) + \varepsilon_{\boldsymbol{t}}^{\boldsymbol{i}} \quad (3)$$

where i_t is the central bank's rate, *f* is a linear function, Ω_t is the information set, and ε_t^i is the interest rate shock.

We consider a recursive identification scheme and assume that the variables in X_t can be separated into 3 groups: (i) a subset of n_1 variables, X_{1t}, which do not respond contemporaneously to the monetary policy shock, such as the commodity price index, the consumer price index and real GDP; (ii) a subset of n_2 variables, X_{2t}, that respond contemporaneously to it, such as the growth rate of M2, the real effective exchange rate and the stock price index; and (iii) the policy instrument in the form of the central bank rate, i_t.

As in Christiano et al. (2005), the recursive assumptions can be summarized by $\boldsymbol{X}_t = \left[\boldsymbol{X}_{1t}, \boldsymbol{i}_t, \boldsymbol{X}_{2t}\right]'$ and

$$\Gamma_0 = \begin{bmatrix} \underbrace{\gamma_{11}}_{n_1 \times n_1} & \underbrace{0}_{n_1 \times 1} & \underbrace{0}_{n_1 \times n_2} \\ \underbrace{\gamma_{21}}_{1 \times n_1} & \underbrace{\gamma_{22}}_{1 \times 1} & \underbrace{0}_{1 \times n_2} \\ \underbrace{\gamma_{31}}_{n_2 \times n_1} & \underbrace{\gamma_{32}}_{n_2 \times 1} & \underbrace{\gamma_{33}}_{n_2 \times n_2} \end{bmatrix}. \tag{4}$$

We include the monetary aggregate (M2), the real effective exchange rate and the equity price in the set of variables that react contemporaneously to the monetary policy shock (X_{2t}). The commodity price index, the price deflator and the GDP are allowed to react to monetary policy only with a lag (being, therefore, included in X_{1t}).

Given that the policy implementation framework in China includes features of quantity and price-based instruments since the beginning of the nineties, we also consider the case where the growth rate of M2 is used as the policy instrument. In this context, Hafer and Kutan (1994) show that the money demand for M2 in China exhibits price homogeneity. Xie and Xiong (2002) and Zhao and Hui (2004) suggest that interest rate targeting is relevant for evaluating China's monetary policy. Wang and Handa (2007) put forward that the People's Bank of China follows a Taylor-type rule aimed at inflation targeting and output smoothing. Burdekin and Siklos (2008) emphasize the

role played by the conduct of monetary policy that targets the rate of money supply growth. Zhang (2009) highlights that the Chinese central bank follows both price and quantity rules. Thus, we look at the alternative formulation of monetary policy

$$\Delta M_{2,t} = g(\boldsymbol{\Omega}_t) + \boldsymbol{\varepsilon}_t^{\Delta M_2} \tag{5}$$

where $\Delta M_{2,t}$ is the growth rate of M2, g is a linear function, Ω_t is the information set, and $\boldsymbol{\varepsilon}_t^{\Delta M_2}$ is the shock to the growth rate of M2.

Finally, the impulse-response function to a one standard-deviation shock under the normalization of $\Lambda = \boldsymbol{I}$ is given by:

$$\boldsymbol{B}(\boldsymbol{L})^{-1}\Gamma_0^{-1}, \tag{6}$$

where *B(L)* is a matrix valued polynomial in positive powers of the lag operator *L* associated with the regression coefficients,

We use a Monte Carlo Markov-Chain (MCMC) algorithm to assess uncertainty about the distribution of the impulse-response function. For this purpose, we construct probability intervals by drawing from the Normal-Inverse-Wishart posterior distribution of *B(L)* and Σ

$$\beta|_{\Sigma} \sim \mathrm{N}(\hat{\beta}, \Sigma \otimes (X'X)^{-1}) \tag{7}$$

$$\boldsymbol{\Sigma}^{-1} \sim Wishart((T\hat{\boldsymbol{\Sigma}})^{-1}, T-m) \tag{8}$$

where β is the vector of regression coefficients in the VAR system, Σ is the covariance matrix of the residuals, $\hat{\beta}$ and $\hat{\Sigma}$ are the corresponding maximum-likelihood posterior estimates at the mean *X* is the matrix of regressors, *T* is the sample size and *m* is the number of estimated parameters per equation.

4. Data

We use quarterly data primarily compiled from Datastream International, covering the period 1990:1-2013:4. The variables included in the empirical analysis are as follows:

i) Commodity price indices which are used as forward looking variables that help eradicate the price puzzle and proxies for changes in global demand, as well as accounts for the effects of China being an important commodity importer;

ii) The consumer price index which is used as an indicator of the dynamics of inflation;

iii) Real GDP, which represents economic activity, is an indication of the business cycle;

iv) Nominal central bank interest rate which is used as the monetary policy instrument;

v) Money supply, M2, which captures the broad concerns of central banks towards the dynamics of money markets as well as credit conditions (Mallick, 2006), is used as a monetary aggregate alongside the cost of money;

vi) Real effective exchange rate which tracks variations in the foreign exchange market and in the balance of payments;

vii) Stock market price index which allows one to quantify the response of financial markets to monetary and macroeconomic developments.

The data for the commodity price indices are sourced from the International Monetary Fund (IMF). We focus on the all commodity price index which includes both fuel and non-fuel price indices; the non-fuel commodity price index which includes food and beverages and industrial inputs price indices; the food price index which includes cereal, vegetable oils, meat, seafood, sugar, bananas, and oranges price indices; the beverage price index which includes coffee, tea, and cocoa price indices; the agricultural raw materials price index which includes timber, cotton, wool, rubber, and

hides price indices; the metals' price index which includes copper, aluminum, iron ore, tin, nickel, zinc, lead, and uranium price indices; and the fuel (energy) commodity price index which includes crude oil (petroleum), natural gas, and coal price indices. We utilize those commodity price indices in different groupings to measure the behavior of narrow and wide groups of commodities.

All variables are expressed in the logarithms of the first-differences and measured at constant 2005 prices with the obvious exception of the central bank rate, which is expressed in levels and measured in nominal terms. Finally, we include in the set of exogenous variables a constant, and select the optimal lag length to be 1.

5. Empirical results

5.1. Aggregate commodity price

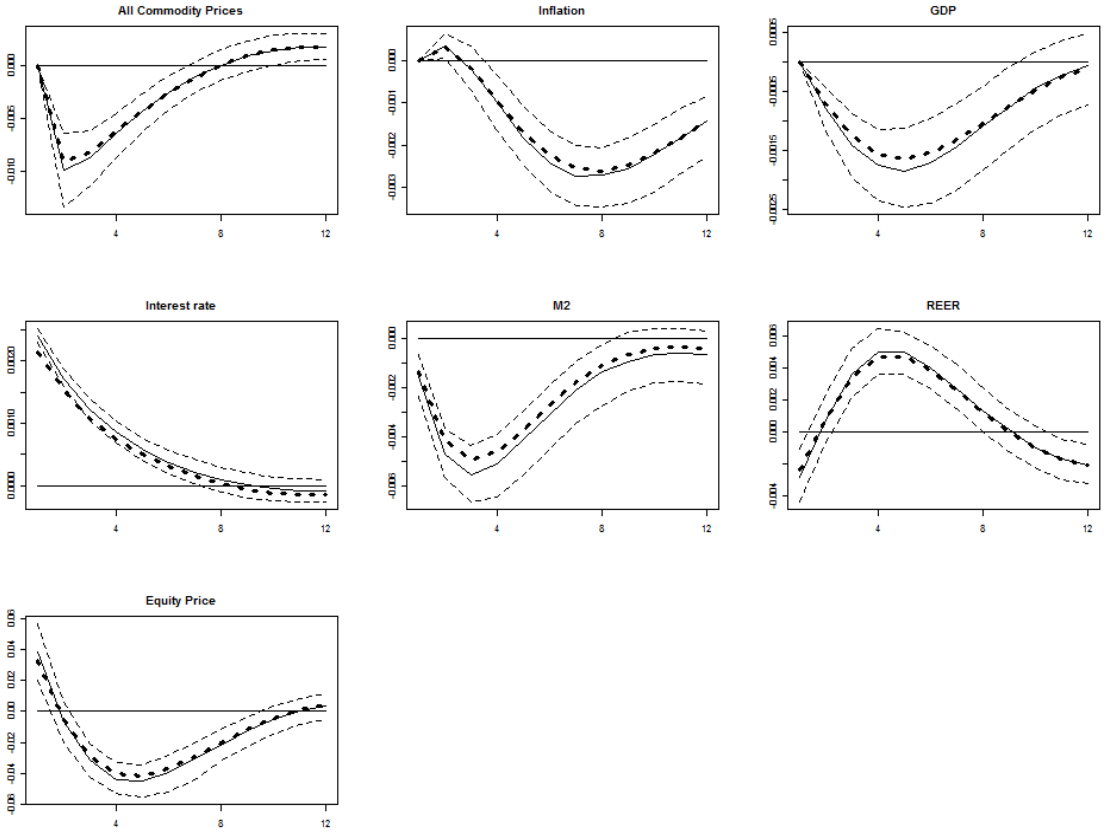
We identify the monetary policy shock by imposing the recursive assumptions defined in Eq. (4) and estimate the BSVAR represented by Eqs. (1)-(2).

Figure 1a plots the impulse-response functions to a positive shock in the interest rate, first when the aggregate commodity price index is used. The solid line corresponds to the point estimate, the dotted line represents the median response, and the dashed lines are the 68% posterior confidence intervals estimated by using a MCMC algorithm based on 10000 draws.

The results show that an unexpected increase of 25 basis points in the interest rate initiated by the People's Bank of China leads to a sharp and persistent fall in the aggregate commodity price index, eventually resulting in a skewed V-shaped dynamics. At the two-quarter horizon, the aggregate commodity price falls by close to 1%. The negative effect lasts for eight quarters, before starting going up. This result is consistent with the general views that rising interest rate would lead to contraction, thereby caus-

ing declines in economic activity variables including GDP and consumption as well as inflation. The contraction reduces China's demand for commodities particularly storable goods and causes global commodity prices to decline. The decreasing tendency in commodity prices can also be explained by the fact that investors in the Chinese financial markets will shift their investments from commodity spot and futures contracts to short-term and long-term government bonds in response to this contractionary monetary policy. The responses of the aggregate price index and the economic activity variables will eventually correct themselves as the contractionary shock runs its course.

Figure 1a. Impulse-responses to a positive interest rate shock: The aggregate commodity price index



The other empirical findings in Figure 1a also reveal that a monetary policy contraction produces a persistent and negative effect on GDP up to five quarters eventually resulting with a standard U-shaped trajectory. A similar U-shape with an initial persistent fall dynamics in the consumer price index is also demonstrated. This initial effect is

somewhat lagged and, thus, starts taking place two quarters after the shock. The dynamics exhibited by the price level is consistent with the work of Zhang (2009), who stresses the effectiveness of the interest rate as a policy instrument.

The positive shock to interest rate also brings a negative impact of -4% on the equity markets at the four-quarter horizon, reflecting the reallocation of asset portfolios towards less risky assets, commonly known as the flight to quality phenomenon. Additionally, it leads to an yuan appreciation of the real effective exchange rate, as investors try to benefit from the higher returns denominated in the Chinese currency. But the exchange rate dynamics eventually document an inverted U-shape as the impact of the interest rate runs its course. Finally, it can be seen that the growth rate of M2 falls in a persistent manner for almost four quarters. This suggests that the rise in the interest rate produces relevant liquidity effects.

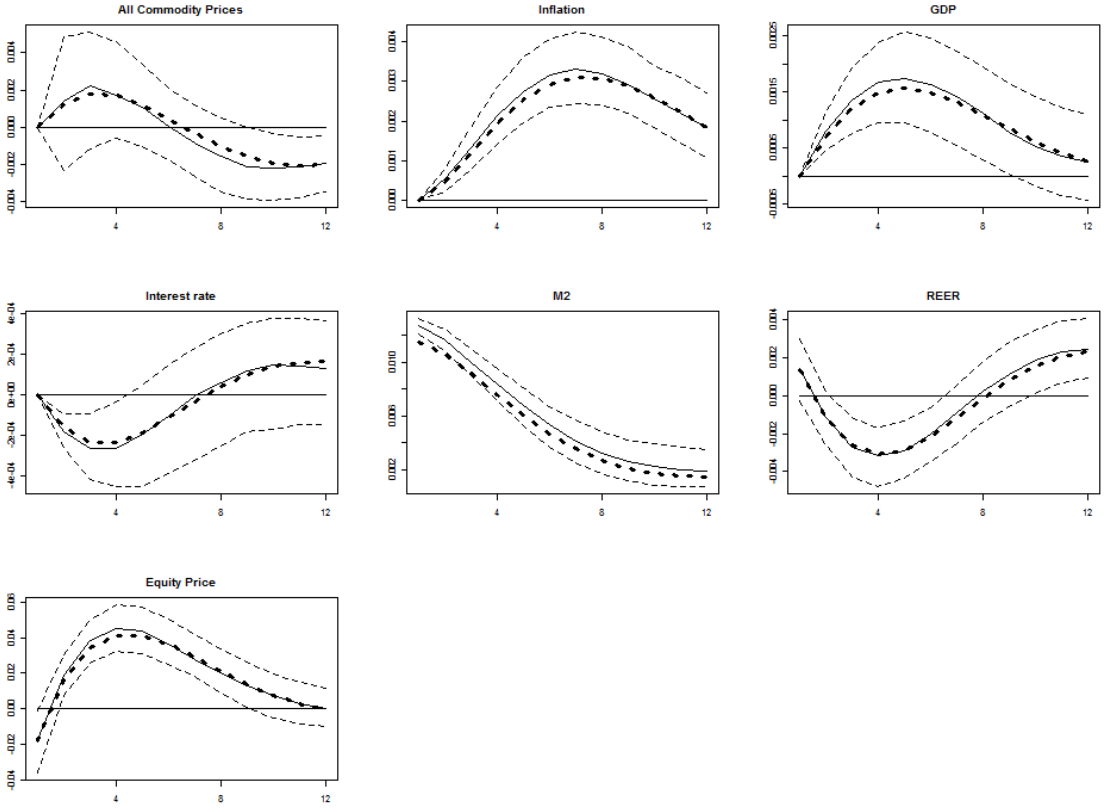
We now assess the impact of a positive (expansionary) shock to the growth rate of M2 when first the aggregate commodity price index is used and report the impulse-responses in Figure 1b. Our empirical results show that the monetary expansion does not affect the aggregate commodity price index in a significant manner and this is possibly due to aggregation. Regardless, this response is different from the response of this variable to the interest rate shock.

On the other hand, we find that the positive shock to the growth rate of M2 has an expansionary effect on the real economic activity, and has also a very persistent and positive impact on the inflation rate as the consumer price index remains higher than its original level 12 quarters after the shock. It also eases the liquidity conditions of money markets, thereby leading to a fall in the interest rate.

As expected, the monetary expansion leads to a depreciation of the domestic currency and boosts equity prices, which rise by 4% for the four-quarter horizon as a result

of increasing monetary liquidity. In this case the stock price response follows an inverted U-shape in response to the positive money supply shock which means this shock also runs its course within a certain period. This increase in equity prices following the expansion in money supply is supported by the "portfolio balance" theory of exchange rates as proposed by Frankel (1983) and Branson (1983), which states that exchange rates respond to changes in the demand for and supply of financial assets such as stocks and bonds as part of portfolio rebalancing.

Figure 1b. Impulse-responses to a positive shock to the growth rate of M2: The aggregate commodity price



Since our strategy for estimating the parameters of the model focuses on the portion of fluctuations in the data that is caused by a monetary policy shock, it is, therefore, natural to ask how large that component is. With this question in mind, Tables 1a and 1b summarize the percentage of the variance of the *k*-step-ahead forecast error due to an interest rate shock and a shock to the growth rate of M2, respectively.

As can be seen, the monetary policy shocks to the interest rate account for a small fraction of the variations in the aggregate commodity price index (2% in the case of the interest rate shock vs. 1.1% in the case of the shock to the monetary aggregate 12 quarters ahead). This finding underscores the prowess of the interest rate or the price shock over the money supply or quantity shocks for the commodity price index. Moreover, the interest rate shocks are responsible for 3.1% of the variations of GDP, 5.9% of the variations of inflation and 5.3% of the variations of the equity price 12 quarters ahead, while shocks to the growth rate of M_2 represent 4%, 5.2% and 10.2% of those variations, respectively, portraying a mixed picture between the two types of shocks for GDP.

Table 1a. Percentage variance due to a positive interest rate shock: The aggregate commodity price

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	1.4	1.8	2.0
	[0.0; 0.0]	[0.8; 2.3]	[1.1; 2.7]	[1.3; 2.9]
Inflation	0.0	0.8	4.7	5.9
	[0.0; 0.0]	[0.4; 1.3]	[2.9; 6.9]	[3.9; 8.8]
GDP	0.0	1.4	2.6	3.1
	[0.0; 0.0]	[0.6; 2.5]	[1.3; 4.8]	[1.8; 5.4]
Interest rate	59.6	30.5	21.3	19.1
	[54.5; 64.4]	[26.1; 35.1]	[17.8; 25.7]	[15.5; 22.9]
M_2	1.6	7.6	6.7	6.5
	[0.7; 3.3]	[4.5; 10.9]	[4.1; 10.4]	[4.3; 10.1]
Exchange rate	1.2	3.8	4.4	4.7
	[0.4; 2.7]	[2.4; 5.4]	[2.9; 6.2]	[3.4; 6.3]
Equity price	1.4	3.8	5.2	5.3
	[0.5; 3.0]	[2.5; 5.3]	[3.6; 7.2]	[3.7; 7.1]

Notes: The median and 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

Table 1b. Percentage variance due to a positive shock to the growth rate of M2: The aggregate commodity price

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	0.4	0.8	1.1
	[0.0; 0.0]	[0.2; 0.9]	[0.4; 1.4]	[0.7; 1.8]
Inflation	0.0	2.0	8.4	10.2
	[0.0; 0.0]	[1.0; 3.4]	[4.7; 12.6]	[6.0; 14.5]
GDP	0.0	1.3	2.9	4.0
	[0.0; 0.0]	[0.5; 2.6]	[1.4; 5.3]	[2.0; 6.5]
Interest rate	0.0	0.6	1.7	2.9
	[0.0; 0.0]	[0.3; 1.4]	[0.9; 3.3]	[1.6; 5.4]
M_2	86.6	43.9	33.3	30.7
	[81.9; 90.3]	[37.8; 49.6]	[27.5; 38.6]	[25.2; 36.8]
Exchange rate	0.7	2.4	2.9	4.1
	[0.3; 1.5]	[1.4; 3.9]	[1.9; 4.6]	[2.7; 6.0]
Equity price	0.9	3.5	4.8	5.2
	[0.4; 1.9]	[2.3; 5.2]	[3.2; 7.0]	[3.5; 7.3]

Notes: The median and 68% probability bands (in square brackets) computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

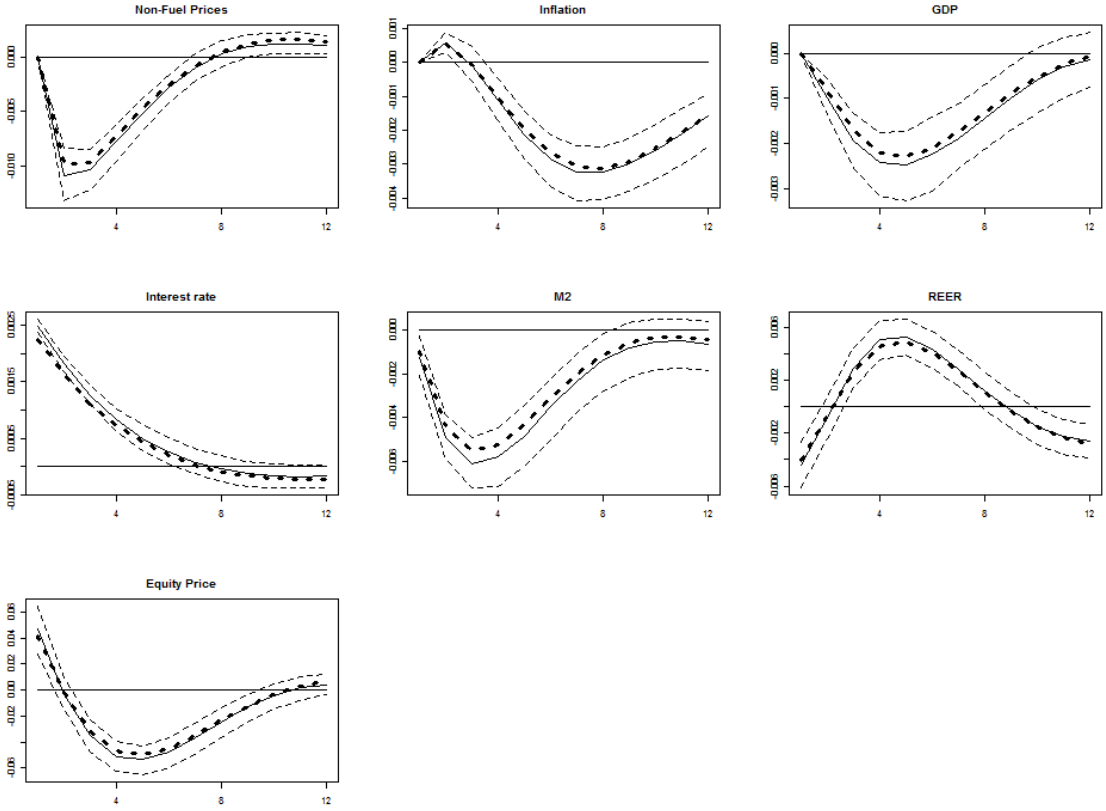
5.2. Non-fuel commodity prices

We now replace the aggregate commodity price index with the non-fuel commodity price index in the BSVAR, keeping the other variables in this case the same. Figure 2a displays the impulse-responses to a positive shock to the interest rate, while Figure 2b plots the impulse-responses to a positive shock to the growth rate of M_2.

Figure 2a shows that a 25 basis points shock to the interest rate of the People's Bank of China leads to a sharp fall (of close to -1%) in the prices of the non-fuel commodities. The effect is also persistent on a U-shaped trajectory, as these prices remain lower than their original levels for about eight quarters. This result suggests that this interest rate shock has similar impacts on all commodity and non-fuel indices, attesting to its comprehensive effectiveness on these commodity prices.

We also find that the positive interest rate shock has also a contractionary effect on the level of the real output and, despite the lag of four quarters, it also leads to a persistent fall in the consumer price index. As before, the equity prices decrease, the real effective exchange rate appreciates and the liquidity conditions tighten in response to the shock and the effects persist for about eight quarters.

Figure 2a. Impulse-responses to a positive interest rate shock: The non-fuel commodity prices

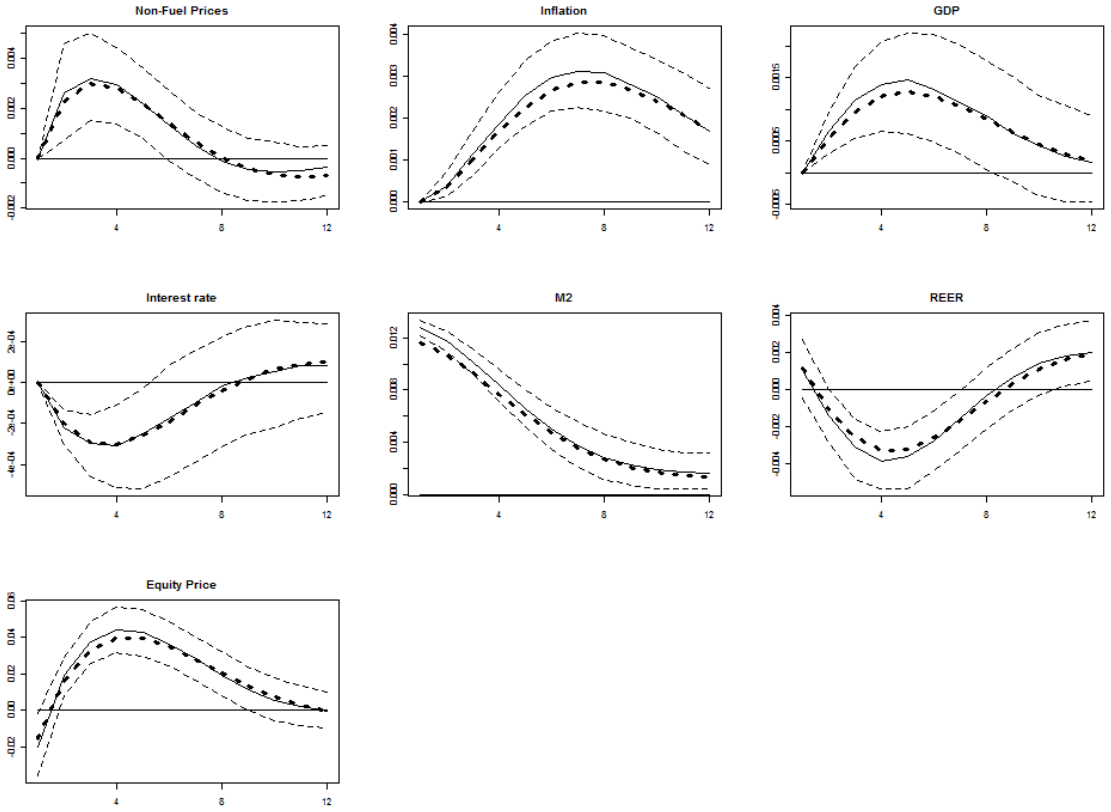


In what concerns the positive shock to the growth rate of M2 (Figure 2b), the results broadly mirror the ones found for the shock to the interest rate. Interestingly, while the monetary expansion does not seem to have any significant effect on the aggregate commodity prices, we note that non-fuel commodity prices are given a persistent (eight quarters) and small (0.3%) boost by the unexpected rise in the growth rate of M2. Additionally, the monetary expansion has a positive and persistent effect on both the inflation rate and the real GDP. It also leads to important asset portfolio reallocation effects as the equity prices rise and the domestic currency depreciates. This finding implies that investors increase their demand for risky assets with higher yields, and that there would also be a flight towards currencies with higher returns.

All in all, while the macroeconomic impact of the two types of shocks is similar, the magnitude of the response of non-fuel commodity prices is substantially larger in

the case of an interest rate shock. Therefore, the use of this policy instrument seems to be more effective at influencing the dynamics of the non-fuel commodity prices.

Figure 2b. Impulse-responses to a positive shock to the growth rate of M2: The non-fuel commodity prices



Tables 2a and 2b provide a summary of the forecast-error variance decomposition due to the interest rate shock and the shock to the growth rate of M2, respectively. While the interest rate shock explains 5.5% of the variations of the non-fuel commodity prices at the 12 quarters horizon, that fraction falls to 1.5% in the case of a shock to the growth rate of M2. This again highlights the importance of the price instrument over the quantity instrument.

At the 12 quarters horizon, both interest rate and money supply shocks are responsible for the variations in the inflation rate (7.9% vs. 7.6%, respectively), the real GDP (5% vs.3.1%, respectively) and the equity price (6.8% vs. 4.9%, respectively), which are somewhat similar.

Table 2a. Percentage variance due to a positive interest rate shock: The non-fuel commodity prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	4.9	5.3	5.5
	[0.0; 0.0]	[3.4; 6.5]	[3.8; 7.0]	[4.0; 7.2]
Inflation	0.0	0.9	5.9	7.9
	[0.0; 0.0]	[0.6; 1.5]	[3.7; 8.9]	[5.3; 11.2]
GDP	0.0	2.2	4.6	5.0
	[0.0; 0.0]	[1.1; 3.9]	[2.5; 7.2]	[2.9; 7.7]
Interest rate	65.5	33.5	22.6	20.7
	[60.0; 70.5]	[29.2; 38.2]	[19.1; 26.9]	[16.7; 24.8]
M_2	0.9	9.1	8.3	8.0
	[0.3; 2.4]	[6.2; 12.3]	[5.5; 12.2]	[5.5; 11.6]
Exchange rate	2.3	4.0	4.8	5.4
	[1.1; 4.3]	[2.7; 5.7]	[3.3; 6.9]	[3.9; 7.1]
Equity price	2.2	4.5	6.7	6.8
	[0.9; 4.0]	[3.0; 6.5]	[4.9; 8.8]	[5.0; 8.8]

Notes: The median and 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

Table 2b. Percentage variance due to a positive shock to the growth rate of M_2: The non-fuel commodity prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	0.6	1.1	1.5
	[0.0; 0.0]	[0.3; 1.3]	[0.6; 1.9]	[0.8; 2.3]
Inflation	0.0	1.2	5.8	7.6
	[0.0; 0.0]	[0.5; 2.4]	[3.1; 9.8]	[4.6; 11.8]
GDP	0.0	0.8	2.2	3.1
	[0.0; 0.0]	[0.3; 1.9]	[1.0; 4.3]	[1.6; 5.7]
Interest rate	0.0	0.8	1.8	2.8
	[0.0; 0.0]	[0.4; 1.7]	[1.0; 3.3]	[1.6; 5.0]
M_2	87.2	43.4	32.6	30.5
	[83.5; 90.8]	[38.0; 49.8]	[26.9; 39.3]	[24.5; 37.0]
Exchange rate	0.8	2.5	3.0	3.9
	[0.3; 1.7]	[1.6; 4.0]	[1.9; 4.7]	[2.4; 5.7]
Equity price	0.7	3.2	4.5	4.9
	[0.3; 1.7]	[1.9; 4.7]	[3.1; 6.6]	[3.4; 7.1]

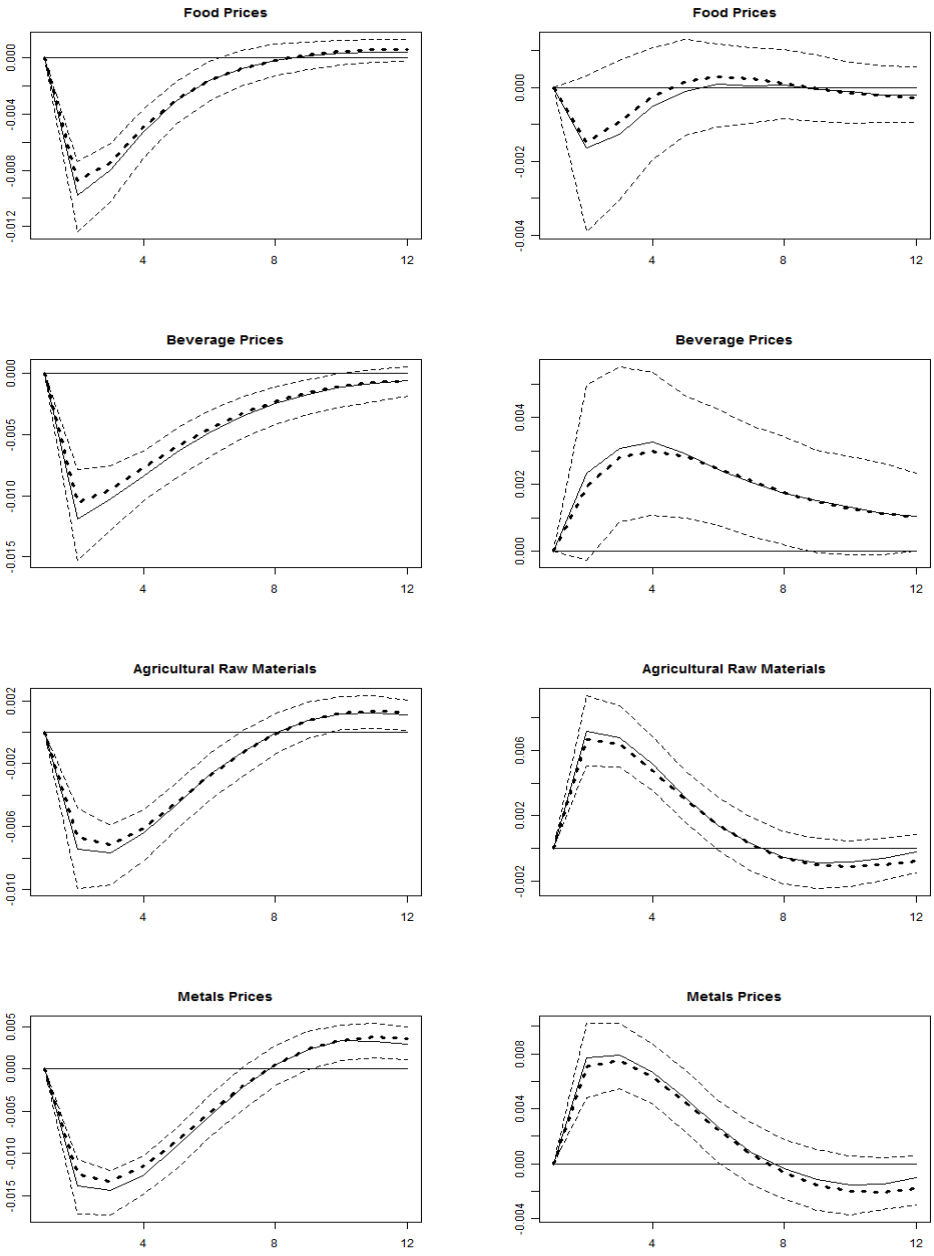
Notes: The median and 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

In order to provide a disaggregate assessment of the impact of monetary on non-fuel commodity prices, we replace, one at a time, the non-fuel commodity price index with (i) the food prices, (ii) the beverage prices, (iii) the prices of agricultural raw materials, and (iv) the prices of metals in the BSVAR. More specifically, the B-SVAR is re-estimated each time with a specific item of the non-fuel commodity price index being included in the system. For brevity, we only plot the responses of the various prices of the non-fuel commodities to the two monetary policy shocks (Figure 3).[1]

[1] The impulse-response functions for all the variables included in the system are available upon request addressed to the corresponding author.

Figure 3. Impulse-responses to a positive interest rate shock and a positive shock to the growth rate of M2: The food prices, beverage prices, prices of agricultural raw materials and metals prices

Positive interest rate shock Positive shock to the growth rate of M2



With regard to the positive shock to the interest rate, the empirical evidence is consistent with what we find for the non-fuel commodity price index and suggests that the monetary contraction has a negative and significant impact on the four non-fuel commodity prices under consideration. In all cases, the effect is persistent and lasts for eight quarters. The trough occurs two quarters after the shock and stands at: -0.7% in the case of the agricultural commodity prices; -0.8% for the food prices; -1% for the

beverage prices; and -1.2% for the prices of the metals. Therefore, the metal commodity prices are particularly sensitive to unexpected changes in the interest rate of the People's Bank of China. As indicated in the introduction, China consumes for example 40% of the world's copper demand, making it the highest world consumer of copper. Moreover, it has become the world's largest gold-consuming nation, overtaking India in 2013. The result reflects the fact that China is the world's factory and export machine.

As for the positive shock to the growth rate of M2, the results show that the monetary expansion has a positive impact on both the prices of agricultural raw materials and metals, with the peaks of, respectively, 0.7% and 0.8% being achieved at the two-quarter horizon. The effects disappear after eight quarters. In the case of the beverage prices, the shock to the growth rate of M2 has also a positive impact. However, while the magnitude of the response at the peak is smaller (0.2%), the effect is also more persistent, as the beverage prices remain higher than their original levels 12 quarters after the shock. Finally, we do not find any significant effect of the monetary expansion on the food prices.

In Tables 3a and 3b, we report the forecast-error variance decomposition due to the interest rate shock and the shock to the growth rate of M_2, respectively. As before, we only present the portion of the fluctuations in the non-fuel commodity prices that are caused by the two types of monetary policy shocks. Table 3a shows that, at the 12-quarter horizon, the interest rate shock explains 5.3% of the variations in the prices of the metal commodities and 4.8% of the variations in the prices of beverages. As for the shock to the growth rate of M_2, it accounts for 2.8% of the variations in the prices of agricultural raw materials and 2.1% of the variations in the prices of metals at the 12-quarter horizon. These explanations of the interest rate shocks of the variations in the different prices are close to each other, although they also highlight the differential

strength of the interest rate shock over the monetary shock. Thus, it is possible that those commodities are purchased on credit with loaned money.

Table 3a. Percentage variance due to a positive interest rate shock: The food prices, beverage prices, agricultural raw materials and metals prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Food prices	0.0	3.1	3.5	3.6
	[0.0; 0.0]	[1.9; 4.6]	[2.3; 5.0]	[2.5; 5.3]
Beverage prices	0.0	3.4	4.6	4.8
	[0.0; 0.0]	[2.0; 5.1]	[2.9; 6.4]	[3.2; 6.7]
Prices of agricultural raw materials	0.0	2.7	3.2	3.4
	[0.0; 0.0]	[1.5; 4.0]	[2.1; 4.7]	[2.3; 4.9]
Prices of metals	0.0	4.3	5.0	5.3
	[0.0; 0.0]	[3.1; 6.0]	[3.6; 6.9]	[3.9; 7.3]

Notes: The median and the 68% probability bands (in square brackets) are computed using the Markov-Chain Monte Carlo (MCMC) algorithm.

Table 3b. Percentage variance due to a positive shock to the growth rate of M2: The food prices, beverage prices, agricultural raw materials and metals prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Food prices	0.0	0.4	0.7	0.9
	[0.0; 0.0]	[0.2; 0.8]	[0.4; 1.3]	[0.6; 1.6]
Beverage prices	0.0	0.6	1.1	1.4
	[0.0; 0.0]	[0.3; 1.1]	[0.6; 1.9]	[0.8; 2.3]
Prices of agricultural raw materials	0.0	2.0	2.5	2.8
	[0.0; 0.0]	[1.2; 3.2]	[1.6; 3.7]	[1.9; 4.2]
Prices of metals	0.0	1.3	1.7	2.1
	[0.0; 0.0]	[0.7; 2.2]	[1.1; 2.7]	[1.4; 3.2]

Notes: The median and the 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

5.3. Fuel (energy) commodity prices

We now investigate the impact of a monetary policy shock on fuel (energy) commodity prices. Figure 4a plots the impulse-responses to a positive interest rate shock. We first find that the monetary contraction leads to an immediate fall in fuel (energy) commodity prices, with a trough of -0.5% at the two-quarter horizon and the negative effect persisting for eight quarters. Given the importance of the Chinese economy, a contractionary shock affects global growth and world demand for oil.

As before, the positive interest rate shock also generates: (i) a contraction in real economic activity that lasts for about 12 quarters; (ii) a fall in consumer prices that takes place with a lag of four quarters; (iii) a tightening of liquidity conditions, as the growth rate of M_2 falls for eight quarters; (iv) an appreciation of the domestic currency; and (iv) a fall in equity prices.

Figure 4b displays the impulse-response functions associated with a positive shock to the growth rate of M2. As in the case of the aggregate commodity price and the food commodity prices, the empirical findings do not lend support to a significant impact of monetary policy on the fuel (energy) commodity prices. Spending on those commodities is discretionary and the users can adjust as time goes on. Moreover, these prices are very volatile and are highly sensitive to geopolitical events.

However, the positive shock to the growth rate of M2 has a relevant expansionary effect on real output and leads to a rise in inflation. Moreover, it leads to a depreciation of the domestic currency and an increase in equity prices, as a consequence of the increase in the investors' appetite for assets that are riskier, but also delivers higher returns. Similarly, the shock eases market liquidity conditions, albeit only temporarily, as the interest rate falls significantly for just four quarters.

Figure 4a. Impulse-responses to a positive interest rate shock: fuel (energy) commodity prices

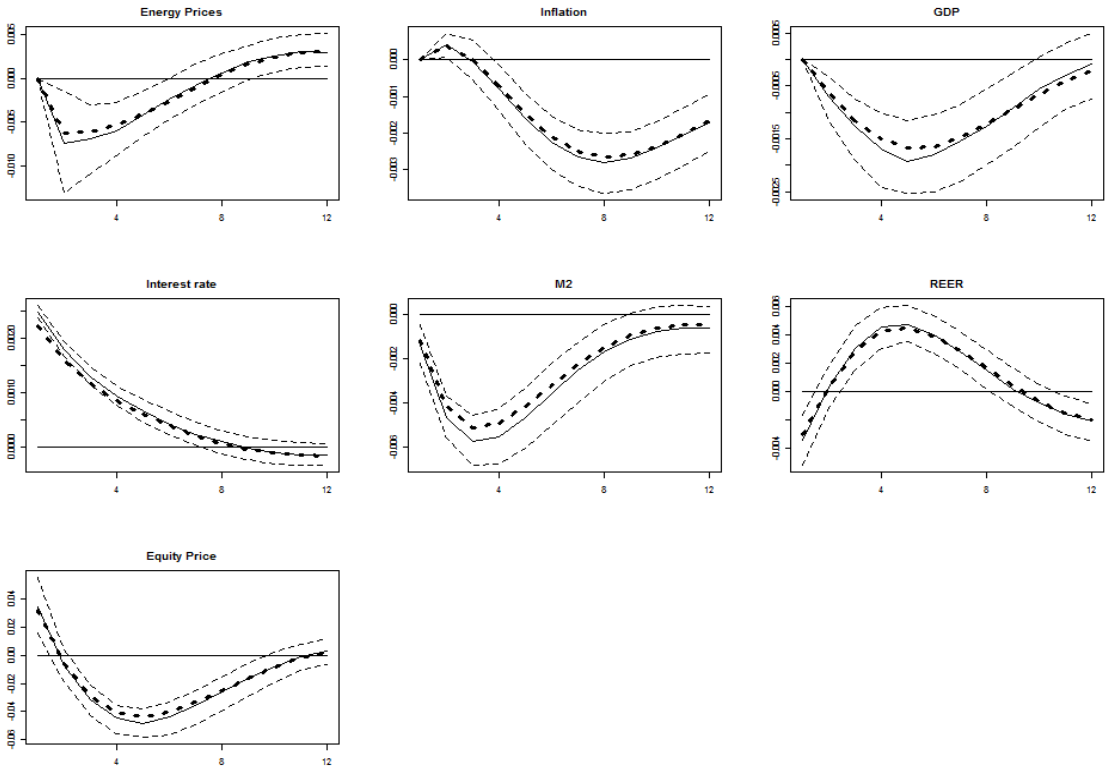
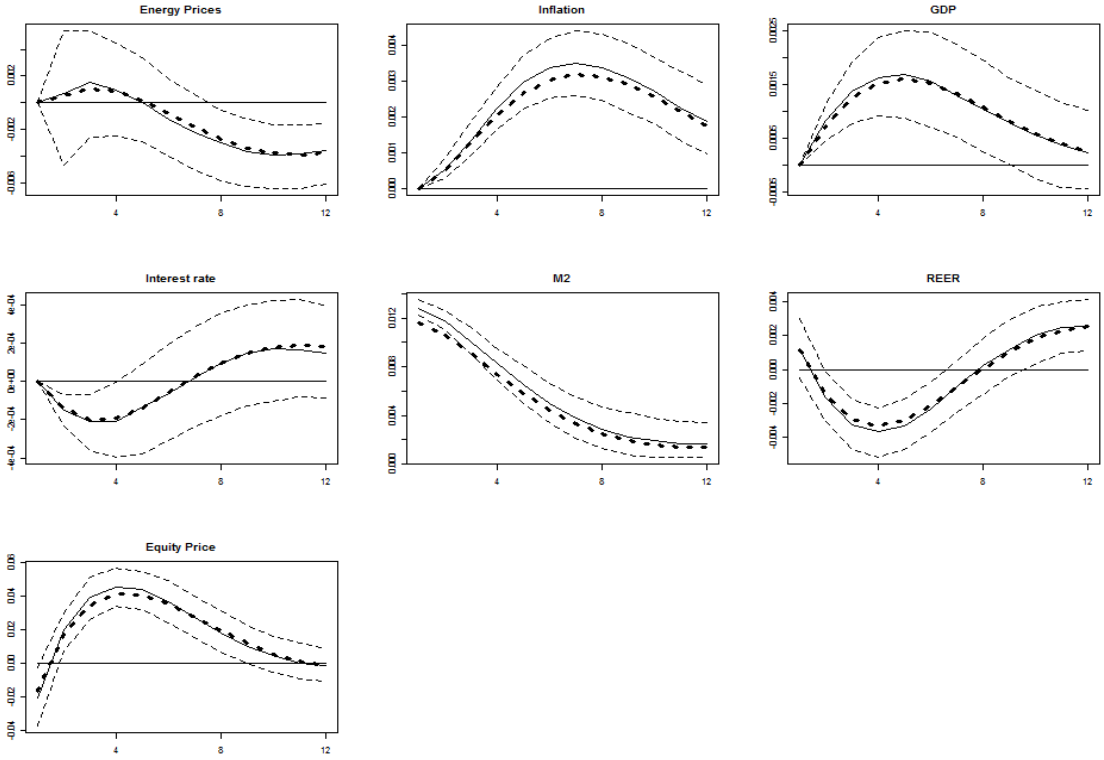


Figure 4b. Impulse-responses to a positive shock to the growth rate of M2: fuel (energy) commodity prices



In Tables 4a and 4b, we present the forecast-error variance decomposition due to two monetary policy shocks under analysis. At the 20-quarter horizon, the shocks account for a residual fraction of the variations in the fuel (energy) commodity prices (1.3% in the case of the interest rate shock and 1.2% for the shock to the growth rate of M2). However, the monetary policy helps explain a reasonably large percentage of the forecast-error variance of inflation (6.1% in the case of the interest rate shock and 9.8% for the shock to the growth rate of M2) and the equity price (5.7% in the case of unexpected variation in the interest rate set by the People's Bank of China and 5.1% for the shock to the growth rate of M2).

Table 4a. Percentage variance due to a positive interest rate shock: The fuel (energy) commodity prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	0.7	1.1	1.3
	[0.0; 0.0]	[0.3; 1.3]	[0.6; 1.7]	[0.8; 2.1]
Inflation	0.0	0.7	4.3	6.1
	[0.0; 0.0]	[0.4; 1.3]	[2.5; 6.8]	[3.8; 9.3]
GDP	0.0	1.3	3.2	3.6
	[0.0; 0.0]	[0.6; 2.6]	[1.5; 5.3]	[1.9; 6.1]
Interest rate	61.2	35.0	24.0	21.3
	[56.4; 66.3]	[30.6; 39.5]	[20.1; 28.4]	[17.1; 25.5]
M_2	1.4	8.6	8.3	8.0
	[0.5; 2.8]	[5.5 11.5]	[5.1; 11.5]	[5.3; 11.2]
Exchange rate	1.6	3.5	4.4	4.8
	[0.6; 3.1]	[2.3; 4.8]	[3.0; 6.2]	[3.4; 6.3]
Equity price	1.4	3.6	5.7	5.7
	[0.5; 3.0]	[2.5; 5.3]	[4.0; 7.7]	[4.2; 7.7]

Notes: The median and 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

Table 4b. Percentage variance due to a positive shock to the growth rate of M2: The fuel (energy) commodity prices

	1 Quarter ahead	4 Quarters ahead	8 Quarters ahead	12 Quarters ahead
Commodity price	0.0	0.4	0.8	1.2
	[0.0; 0.0]	[0.2; 0.7]	[0.4; 1.3]	[0.6; 1.9]
Inflation	0.0	2.0	8.5	9.8
	[0.0; 0.0]	[1.1; 3.5]	[5.2; 12.6]	[6.4; 14.2]
GDP	0.0	1.4	2.8	3.6
	[0.0; 0.0]	[0.5; 2.6]	[1.3; 5.2]	[2.0; 6.4]
Interest rate	0.0	0.6	1.7	2.6
	[0.0; 0.0]	[0.3; 1.3]	[0.9; 2.9]	[1.5; 4.8]
M_2	87.5	42.9	32.0	29.4
	[83.3; 91.0]	[37.0; 48.9]	[26.0; 38.1]	[24.2; 35.5]
Exchange rate	0.7	2.6	3.2	4.2
	[0.3; 1.8]	[1.7; 4.0]	[2.1; 4.7]	[2.9; 6.1]
Equity price	0.8	3.5	4.8	5.1
	[0.3; 1.7]	[2.2; 5.2]	[3.1; 6.9]	[3.5; 7.1]

Notes: The median and 68% probability bands (in square brackets) are computed using a Markov-Chain Monte Carlo (MCMC) algorithm.

5. Conclusion

There is now empirical evidence to support the theoretical arguments that monetary policies of major economies are important determinants of international commodity prices but the monetary tools have differential prowess. Some authors argue that low interest rates and increased global liquidity infused by greater money supply over the recent period have contributed to the continued surges in global commodity prices (e.g., Frankel, 2008; Belke et al., 2014).

Our study addresses the issue of monetary policy effects on commodity prices in the context of China, which is now the second-largest economy in the world and one of

the world's leading consumers and producers of commodities. Given China's specific role on the world commodity markets, not only its increasing demand for commodities but also its stylized monetary policy may help explain the movements in global commodity prices. Accordingly, a Bayesian SVAR model is implemented in this study to identify the shocks affecting the interest rate and money growth (M2) managed by the People's Bank of China, and evaluate their effects on the aggregate commodity prices as well as sector commodity prices.

Considering the quarterly data from 1990 until 2013, our empirical results uncover several important facts. First, a positive (contractionary) shock to the interest rate of the Chinese central bank lowers the aggregate commodity price index. This result is in line with the works of Frankel and Hardouvelis (1985) and Belke et al. (2014), who also find evidence of a significant negative relation between the policy interest rate and the broad commodity price index. On the other hand, we find that the impact of an expansionary shock to the growth rate of the M2 monetary aggregate on the aggregate commodity index is not significant. The findings suggest that a price policy instrument is more powerful than a quantity policy instrument in explaining the dynamics of global commodity prices.

Second, our results show that the price reactions of different commodity groups to the shocks affecting both interest rate and M2 are not alike. For instance, among the commodity sector prices we discover that the prices of beverages and metals fall the most in response to an increase in the Chinese interest rate. On the other hand, the positive shock to the growth rate of the M2 monetary aggregate significantly drives up the non-fuel commodity prices and metals prices, but not the volatile food prices and fuel (energy) commodity prices. These findings can be explained by the differences in the characteristics of the different groups of commodities. Indeed, the lower sensitivity of

the food and energy commodity prices to changes in monetary policy is due to their uses as basic products in consumption and production with relatively low price elasticities of demand. These commodities are also more dependent on other factors such as weather, storage, geopolitical conditions and probably the cost of credit. As to the metal prices, they are particularly affected by the monetary policy actions because they bear monetary values and are commonly used as a hedge against inflation (Baur and McDermott, 2010; Beckmann and Czudaj, 2013).

Finally and despite the fairly similar macroeconomic impact of the two types of monetary policy shocks, the interest rate appears to be a more effective monetary policy tool, as its shock has a greater impact on commodity prices than the shock to the money supply. Overall, this finding supports the Chinese government's recent reforms in freeing the domestic interest rate and ending the financial repression. This instrument is now proven to be an effective policy that the People's Bank of China can use.

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